HEURISTICS, ANECDOTE, AND APPLYING "ART": WHY WAR THEORISTS ARE KIDDING THEMSELVES

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USAWC STRATEGY RESEARCH PROJECT

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ABSTRACT

Contemporary war theorists face a bedeviling thicket of problems precluding accurate forecasting or estimation. War is a complex, multivariate, and difficult-to-define enterprise; it is a quintessentially human activity, arising from man's emotional and rational makeup, his civilization, his genetic heritage, and his environment. War theorists' personal familiarity with the planning, practice and consequences of war drive their adoption of a philosophical—non-scientific—framework for understanding which ignores underlying physical phenomena in favor of broad "principles." Yet just as philosophers have been unable to divine the purpose of human existence through discourse, war theorists fail to explain the causes and outcomes of human conflict when they substitute anecdotal evidence for data, derive heuristics from small sample sizes, and eschew science as "reductionist"—incapable of accurate prediction in a realm as complex as human behavior. We must replace empirical (observation-based) methods and artful heuristics with the rigorous tests of hypothesis-based science, building up from low-level physical and social phenomena arising in the neurophysiology of human brains, to eventually answer behavioral questions unsolved for millennia.

HEURISTICS, ANECDOTE, AND APPLYING "ART": WHY WAR THEORISTS ARE KIDDING THEMSELVES

> One should learn under severe caution. History is certainly not a place to theorize or derive general knowledge, nor is it meant to help in the future, without some caution. We can get negative confirmation from history, which is invaluable, but we get plenty of illusions of knowledge along with it.
>
> —Nassim Nicholas Taleb,
> *The Black Swan: The Impact of the Highly Improbable*[1]

Background

A theory of war is no theory at all if it cannot be set down as a suite of linked hypotheses which can be independently tested and refuted through experiment. The falsifiability of a theory's propositions—the ability to *disconfirm* statements through rigorous testing—goes to the heart of what makes science a more useful methodology than, say, astrology, phrenology, palmistry, or even some of the statistical extrapolations used in contemporary economic forecasting.[2] Empirical methods (which rely on observation but include no testable hypotheses) are a definite improvement, but fall short of what science demands. It is not enough to observe and then assert after the fact; one has to describe a rationale (a *hypothesis*) for the observed data and seek means for testing that rationale.

Thus, if you wish to formulate a "principle" of war, you should be prepared to explain how your principle could be invalidated, and seek to perform tests that may refute it. When you succeed in that disconfirmation, you can restructure your theory to accommodate the new data you have uncovered. This is how theories become, in the language of Karl Popper, *less bad*.[3]

Theories that make positive assertions about war, without providing any mechanism for refutation, are often worse than useless. Nassim Taleb's (author of *Black Swan*) concerns regarding historical observations (and the accompanying illusion of knowledge they foster) are well-founded.[4] Without a means to test the assertion, such statements reflect little more than personal opinion, are encoded as rules of thumb, and are used as guides by war practitioners far outside their original sphere of applicability (if any). If we intend to get beyond unfalsifiable pronouncements and principles, we will need to introduce the propositions of war theory to the rigor of the scientific method.

First things first. Before we attempt to characterize war, model it, predict its outcome, or submit and test hypotheses regarding its fundamental nature, we ought to define it.[5] Sun Tzu—perhaps our oldest war theorist with a bibliography—simply fails to do so.[6] Plausibly, he may have imagined that the answer to "what war is" ought to be self-evident to anyone who might find cause to peruse his writings. Orwell[7] had occasion to define war in his dystopian novel *1984*, yet his cynical conclusion ("War is Peace") sheds very little light on what makes war. Carl Von Clausewitz cuts to the heart of the matter, famously calling war "an act of force to compel an enemy to do our will."[8] The force in question is constrained to be a *physical* (not economic or moral) *force*, and the enemy defined as a political community or polity. Thus, physical violence conducted between family members or as a result of a mob uprising generally does not constitute war; only states—or entities which either resemble them or wish to become them—are eligible for war making. Orend notes:

> …it seems that all warfare is precisely, and ultimately, about governance. War is a violent way for determining who gets to say what goes on in a

given territory, for example, regarding: who gets power, who gets wealth and resources, whose ideals prevail, who is a member and who is not, which laws get made, what gets taught in schools, where the border rests, how much tax is levied...War is the ultimate means for deciding these issues if a peaceful process or resolution can't be agreed upon.[9]

If we take Clausewitz's definition as a starting point, and add Orend's insightful observations regarding governance, we have a reasonable definition insofar as it provides convenient sociological boundaries for war (restricting the subject matter to conflict between polities or polity-like entities). Thus: War is an act of physical force to compel an enemy polity to do our will—a violent, coerced compliance with our demands.

Once we stray beyond this basic definition, however, the subject quickly becomes muddled. Despite lengthy exposition on the nature of war, its causes, and how to prosecute it, Clausewitz himself admits in an 1830 postscript, "[my theory] can be regarded a nothing more than a collection of materials from which a theory of war was to have been distilled."[10] This is not self-deprecation; the difficulties inherent in constructing even the broadest outlines of a theory intended to describe as complex a sociological phenomenon as war are immense. Consider: We are trying to create an explanation for the combined actions and effects of thousands or even millions of independent, intelligent agents—without *first constructing a verifiable theory for how those intelligent agents operate and behave, individually and in concert*. Clausewitz understood the danger, and he is offering us an implicit warning: *proceed skeptically*. We should take him at his word.

This paper recommends the construction of a theory[11] of war based on scientific principles, and explains why many previous efforts to do so have failed after falling prey to a variety of common fallacies, including small sample sizes, availability and

selectability (or confirmation) biases, and circular reasoning. Clausewitz himself hinted

at this, noting that some philosophers will attempt to "deduce universal laws" while

others will never "rise above anecdote," delving too shallowly to uncover those factors

that link disparate battles and events.[12] This is *not* to say that Clausewitz, his

precursors and contemporaries, or for that matter current war theorists, do not provide

insights and useful paradigms for analyzing or understanding war. They in all likelihood

do. But how can we tell? What is missing is an uncompromising application of the

scientific method—to include (1) comprehensive and systematic observation of war-

related phenomena, to a level of depth that would make many "theorists" quail; (2) the

construction of appropriate hypotheses based on such observation; and (3), the testing

of such hypotheses to determine their validity---with an eye to *disconfirming* rather than

confirming the propositions at issue.[13] Without scientific rigor, the empirically-based

insights of a Clausewitz, a Sun Tzu, a Colin Gray, a Bernard Brodie, or a Jomini are

simply speculative—built on anecdotal evidence and embodied in heuristics.[14,15] While

such heuristics might stand a commander or civilian policy maker in good stead, they

are no substitute for testable—and thus *falsifiable* or *refutable*—hypotheses backed up

by relevant data.   For example, Luttwak describes the nearly apocryphal "three-to-one"

rule describing the strength required by an "attacker" to defeat a "defender."[16] Such a

rule entails a corresponding hypothesis, one which (at least theoretically) could be

tested; yet where is the data to support the rule? And in what situations or under what

conditions does such a rule apply?

Colin Gray understood the conundrum faced by the social scientist who attempts

to apply precise formalism to the study of war—human behavior is complex and

apparently irrational at times, and individual behavior does not necessarily "average out" over large populations.[17] A single individual (or small group of individuals) can often sway a polity's strategic decision-making process, or produce an unexpected result in wartime (for example, through unusually courageous, cowardly, or treasonous behavior). This strong sensitivity to initial conditions is analogous to the "butterfly effect" often cited when describing the unpredictability of the weather: predictive models of atmospheric phenomena are heavily dependent on their inputs and often produce divergent results after only one or two days.[18] This is at odds with the optimistic view of sociology's power, propounded by the 19th-century political economist Vilfredo Pareto and enlarged upon by the 20th century author and futurist Isaac Asimov. Pareto was able to demonstrate the non-random (or non-Gaussian) distribution of wealth in various European societies, and conclude that this represented a general feature of human populations.[19] Asimov suggested that human behavior might be modeled in the aggregate and provides accurate forecasts, according to a set of yet-to-be-uncovered rules.[20] While this appears highly unlikely, the butterfly effect (a shorthand for complexity or chaos theory) does not preclude a quest for improved scientific rigor in other, related disciplines; for example, complexity has not invalidated results from macroeconomics, which also relies on the statistics of large numbers to assess the behavior of human systems, but which—it is asserted—are less sensitive to small changes in initial conditions.

First: Collect Data (Lots of Data!)

How then to begin? First and foremost, a rigorously scientific theory of war must start with comprehensive and systematic observation of relevant phenomena—in short,

data collection. In the case of war, relevant phenomena are manifold and interdependent, including such items as the characteristics of the populations conducting or planning warfare (e.g., number, gender, age, race, educational, religious, ideological and/or cultural, governmental form, and socioeconomic distribution), the characteristics of the territory inhabited by the populations (access to oceans, arable farmland, amount and type of domestically available resources, level of urbanization, level of sophistication of communication and transportation networks, natural terrain barriers to invasion), the characteristics of the physical forces that the population can or has marshaled in its defense (level of technology, types and number of forces, types and effectiveness of training, historical effectiveness in combat, morale), and the characteristics of the interactions among populations—the author is very aware that the proffered list is *not* exhaustive. This fact might well point to a list of relevant phenomena that risks multiplying without limit,[21] causing us to despair at any sort of useful data collection effort. Yet the idea is anything but new. In *Explaining War*, J.D. Singer notes that, "If Georges Clemenceau is noted for pointing out that the conduct of war is too important to be left to the militarists, it is Quincy Wright that reminds us that the analysis of war is too important to be left to the intuitionists."[22]

Singer is the force behind the Correlates of War project, whose results were initially published in the *Journal of Conflict Resolution* in 1970. He seeks to do no less than "lay a foundation for a science of peace and war."[23] Singer's intent is explicitly predictive: He hopes to model conflict "phases" and compare the forecasting power of various explanations for war in terms of the magnitude and duration of military hostilities that result. He builds upon the work of earlier social scientists, including Lewis

Richardson, author of *Statistics of Deadly Quarrels*, who compiled data from various conflicts between 1820 and 1940, with the express intent of determining the underlying causes of these conflicts. Whereas Richardson was content to work at a fairly high level (examining conflicts primarily in terms of the order of magnitude of casualties suffered), other practitioners—such as Trevor Dupuy—attempt to drive even deeper into the details of the conflicts themselves, investigating the relationship between such factors as the range and lethality of weaponry fielded by combatants, and the resultant outcome of battle.[24] While this approach has explanatory power, Depuy's analysis founders on "intangibles": leadership, initiative, morale. How to assess these? Depuy recognizes that an objective assessment of these factors—assuming one could agree on a proper definition for any of them—is probably not possible, so he opts for an indirect assessment based on their observed effects. This is better than adopting simple heuristics (recall Luttwak's "three-to-one" rule), but not by much.

For his part, Singer recognizes the daunting nature of the task that he has undertaken, but is content to put off the vexing question of hypothesis creation and testing until later. He sees his principal task as a collector of germane data, "there is little question…that the greatest need is in the correlational sector. Our desperate requirement now is a data and findings base from which we may proceed to the systematic testing of a multiplicity of plausible explanations for war."[25] Until a critical mass of data can be assembled, there is little sense in building hypotheses—we simply do not know enough to speculate on what such hypotheses might be.

The sparseness of real data has driven "single cause" conjecture on the part of theorists as renowned as Clausewitz and Sun Tzu. Sun Tzu is perhaps the most

dependent on aphorism and the least interested in providing verifiable historical data to back his claims; given the span of centuries between his experiences and ours, it is difficult to know if Sun Tzu—if in fact he existed at all—based his assertions regarding the nature of war on more than the brief historical summaries that have been handed down. (There may well have been more, and varied, but they are likely lost to us.) To take a celebrated example: to buttress his assertion that "attacking the enemy's strategy," rather than his forces or cities, is of overriding import, Sun Tzu (and his interpreters) describes how a king, upon being approached by his adversary's chief strategist sent to parlay, has the strategist beheaded. The outcome, they state, was the loss of the adversary's plans and eventual surrender of his city to the king.[26] While this is certainly a compelling tale, a single incident of questionable historical authenticity is hardly acceptable proof for such a significant proposition. Counterexamples—real or imagined—can easily be offered to deny this contention. For instance, it is certainly conceivable that the enemy king might well have been sufficiently enraged by the murder of his strategist to launch an immediate (and possibly surprising?) counterattack. Had it been successful, the lesson to be drawn would have been quite different. The attractiveness of the narrative fallacy—a "just-so" story that neatly explains the outcome and apparent causal connections of a series of events—ensnares even the most careful war theorists.[27]

The "single event—single cause" theorizing described above is not unique to Sun Tzu; examples can be found in Clausewitz as well, though Clausewitz understands the dilemma he faces and expounds upon it at some length.[28] Where it appears that Clausewitz and Singer part company is when Clausewitz asserts that a "single

thoroughly detailed event" is of greater value than ten events "only touched on."[29] Singer would warn us that a single event cannot give us adequate support for a general theory, no matter how detailed the data.

Singer and his predecessors have embarked on a data collection activity that may require decades or centuries to bear fruit.[30] Clausewitz notes, "...the further back one goes, the less useful military history becomes, growing poorer and barer at the same time."[31] It is very possible that the historical information we have in our possession—from the Greeks onward—may be mostly useless for our purposes, due to its sparseness and questionable validity. All the more reason, then, to expand our data collection efforts. We will not be able to generate useful hypotheses without them.

Second: Form *Testable* Hypotheses

Once in possession of such an ample database, it is possible to form tentative hypotheses that may or may not have explanatory power regarding war's causes, effects, and outcomes. Singer—perhaps prematurely—has advanced a number of propositions regarding the nature of war. For example, following an extensive analysis of over 50 post-1945 civil wars, he established several basic hypotheses for test, including, "the presence of 'semi-democracy' increases the likelihood of civil war," "the greater a state's level of military spending, the greater the likelihood of civil war," and "the greater the cultural polarization in a state, the greater the likelihood of civil war."[32] Singer was able to establish that, of the predictor variables examined, the presence of semi-democracy was the most highly correlated with civil war. Such a finding has immediate application to security strategies in weak or newly formed democratic nations around the globe; they must contend with a historical data set that suggests that they

are more likely to experience insurrection than other forms of government. They should

therefore be watchful.

At this point, one could protest that Singer has not provided us with any profound

insight, and that hypotheses such as these could be verified with *prima facie* evidence.

This is a valid objection, but perhaps an unfair one. Initial hypotheses, emerging as

they must from a new and limited data set, will necessarily be simple. An example from

the dawn of science is illustrative. Johannes Kepler required ten years of painstaking

data analysis before he was able to produce a (correct, verifiable) theory of elliptical

planetary motion about the sun—and his hypothesis was incomplete. It would take

Isaac Newton (working nearly 80 years later) to connect Kepler's basic kinematical

argument with a dynamical "why" by proposing the inverse square law of gravitation.[33] It

is no disrespect to Newton or Kepler to note that the dynamical system they studied—

composed of essentially two bodies and one force—is about as simple a system as can

be contemplated, and in no way exhibits the complexity of sociological and behavioral

phenomena such as war.

War is about human behavior, so any theory we might concoct had better take

note of that fact and, to be comprehensive, will have to include an explanation of how

human behavior arises at the lowest possible level. We will briefly bypass the

problematic question of whether we have attacked the deep roots of this problem—

human behavior and its basis in physiological phenomena arising in the brain—to

examine some of the dangerous short-cuts used by "theorists" to construct

demonstrably false or unfalsifiable hypotheses regarding war. These unsupported

assertions are elevated to the status of 'principles of war' and the haphazard collection becomes part of war "theory." But simply calling it a theory does not make it one.

Remember: Anecdote Begets Heuristics (Not Theory)

Even a superficial examination of some of the central tenets of either Sun Tzu or Clausewitz immediately runs aground on poorly-formed conjecture. From Sun Tzu[34]:

1. All warfare is based on deception.

2. There has never been a protracted war from which a country has benefited.

3. In war the best policy is to take a state intact; to ruin it is inferior to this.

The first and second assertions admit no exception, and are thus easy to disconfirm. We need only find a single case to nullify the hypothesis. The propositions of nuclear deterrence "theory"—and warfare—are certainly *not* based on deception, but rather on ensuring that your adversary is aware of your capabilities and the conditions under which you will use them. Deception may be used, but it is a dangerous stratagem insofar as it undermines the enemy's ability to gauge the nature and magnitude of the threat posed by your forces. We can conclude that some types of warfare are based on deception (and others not), but that only illustrates the truism of case dependency— where is the universal "principle" of war theory?

Sun Tzu's second assertion fares no better. While protracted war may be exhausting and debilitating to all parties involved, two twentieth-century icons, Mao and Ho Chi Minh, offer glaring counterexamples to the assertion that no benefit accrues to either side. Both emerged triumphant from protracted wars against more powerful foes.[35] Only time will tell whether Al Qaeda adds a twenty-first century object lesson in protracted war. Two down, one remaining.

The third assertion is especially appealing from the standpoint of efficiency. Why destroy what you can leave standing? Yet many observers of Operation Iraqi Freedom found fault with "Shock and Awe" and the ensuing ground campaign, despite its apparent early effectiveness.[36,37] Perhaps a little "ruin" is necessary to convince an adversary that he was convincingly defeated? It is arguable that a more destructive initial phase might have persuaded some (if not all) Iraqis not to take up arms in the counterinsurgency that surfaced in the wake of our 2003 "victory." Perhaps the Romans treated Carthage as it needed to be treated? Note that much of the ambiguity results from a poorly-formed hypothesis—what is "best" in the context of Sun Tzu's China may have little or no relation to what is "best" in 21st-century warfare. The conclusion: Sun Tzu is not confiding war "theory," but anecdotal observation. Taleb's warning should be heeded: Learn with severe caution. Ascribing explanatory power to anecdote is dangerous.[38]

Clausewitz is careful to frame many of his propositions as observations rather than axioms. Since the number of factors that contribute to success in war are numerous and often not easily separated, he repeatedly stresses intuitive "art" over analytic "science": Guidelines are preferable to definitive rules. Yet he does venture to say[39]:

1. Defense is a stronger form of war than attack.

2. Everything in war is very simple, but the simplest thing is difficult.

3. Most intelligence is false, and the effect of fear is to multiply lies and inaccuracies.

The relative strength of the defense probably reached its apogee in World War I, with armies unable to cross the No Man's Land between trenches without unacceptable losses. Does such an assertion apply to modern warfare? How do precision guided munitions or nuclear weapons affect Clausewitz' hypothesis? Insurgencies? There is clearly room for debate. This statement is sufficiently broad in its reach that it is probably not testable (falsifiable) in this formulation. More specificity is needed.

The second assertion relates to Clausewitzian *friction*—the mechanical and organizational difficulties that beset all military units in wartime (and much else besides). The presence of war-induced friction means that armies are more likely to encounter Murphy's Law on the battlefield, that events will not unfold according to plan, that unbreakable items will break and unassailable intelligence prove incorrect. As a well-formed hypothesis, however, it falls short. Clausewitz is not theorizing; rather, he is admonishing the military leader to pay close attention to detail, to look for "single-point failures" in their organizations, equipment, and strategies, and prepare contingency plans for as many as possible. Like the first assertion, Clausewitzian friction—in this formulation, at least—is offered as a heuristic, a rule of thumb. It cannot be tested. And if it is not testable, it does not pass muster as a scientifically formulated hypothesis.

The final assertion, relating to *fog*, has a sociological element incorporated in it which may actually lend itself to testing. While the principal statement—*most intelligence is false*—is too broad to be testable,[40] the supporting phrase regarding lies and inaccuracies could actually be demonstrated by experiment. This leads us to the third and most critical element of the scientific method: Applying verifiable and repeatable tests.

<u>Finally: Test That Hypothesis</u>

While it is beyond the scope of this paper to suggest a detailed test regimen to address any Clausewitzian or other war scholar's axiom, it is certainly possible to reconstruct a hypothesis such as "the effect of fear is to multiply lies and inaccuracies." The author humbly offers the following: "The effect of war-induced stress on soldiers and their officers will cause them to report false intelligence data more frequently than true data, and to commit greater and more significant numbers of errors in the reporting process [for both true and false data] than occurs in a non-war environment." Multiple trials of individuals and groups of human subjects—with combat experience and without—could be exposed to independently verifiable "true" and "false" intelligence and to investigate whether certain kinds of information are preferentially passed to higher headquarters and the level of distortion applied. Such tests could be conducted during simulated wartime conditions, or even during wartime itself.[41]

Note that this is a significant step beyond single cause-single event theorizing. It potentially eliminates selectability bias—the often unconscious effort by the researcher to "cherry pick" data that confirms (rather than disconfirms) their thesis. Disproving a hypothesis by providing a clear disconfirmation can be as important as—and perhaps more important than—confirming evidence. In a very real sense, it is not possible to positively prove hypotheses. Einstein's *theory* of relativity has been tested repeatedly and consistently "passes." This does not imply that a researcher won't uncover new data that disproves the theory tomorrow. It therefore remains a theory—not law, not fact. This tentativeness is crucial to the scientific method. There are no absolutes, and everything will have to be revised upon the appearance of contrary data.

In this section, we will address two specific hypotheses—or perhaps more precisely, assertions—that are enjoying considerable discussion and debate at present. Each case includes the base hypothesis, a brief discussion of some of the critical issues that surround and often muddy the utility of the hypothesis, and a set of suggestions regarding the formulation of testable statements to replace the hypothesis, in order to reliably confirm or disconfirm it. We will also address various test practices, procedures, and technologies that could be used to confirm or disconfirm the revised hypotheses.

Case One: Predicting Adversary Leader Behavior. "Know your enemy…and your victory will never be endangered."[42] Sun Tzu's exhortation to the warrior is millennia old. But is it even possible? Can we not just gain insight, but instead acquire actual predictive capability—a suite of methodologies, perhaps, for determining the likelihood that an individual or group of individuals will act in a certain way? Pierce and Coon[43] discuss both the utility of understanding how an adversary leader reaches decisions, and the vexing problems that face the practitioner who attempts to read the adversary's mind. Clearly, if one can come into the possession of an accurate psychological model or representation of an enemy leader's decision-making scheme, it may be possible to (1) predict how that leader will react in certain situations, which permits a prepared response; (2) control some or all of the information that is conveyed to that leader in order to limit the leader's options or provide false options to place him in an inferior military or political position; (3) predict lower-echelon commanders' behavior, if it can be correlated (due to cultural and other factors) with the leader's behavior; and (4) simulate entire campaigns against an adversary to uncover weaknesses, maximize efficiencies, and limit friendly casualties.

Such a model can be developed from direct observation of human behavior,[44] or it can be based on lower-level physical processes. The first method is top-down, empirical, and susceptible to ignoring crucial low-level phenomena; the second is bottoms-up, analytic, demanding deep understanding of very low-level processes (such as the physics of neurological activity and mind-environment interactions) before building the next layer of theory. How then to proceed?

One approach to a high-order (empirical) theory for assessing adversary leader's intentions adopts the form of psychological profiling of serial killers and terrorists, used by the US Federal Bureau of Investigation and the U.S. Department of Defense, respectively.[45] Salient details of a killer's (or terrorist's) method, coupled with knowledge of his background and history, allow investigators to determine the likely spectrum of next victims, how a crime or act of terror might be committed, where an individual may prefer to live and work, and other conclusions relevant to the task of finding and incarcerating the individual as rapidly as possible. Opinions differ on the efficacy of the tactic, whether the results are derived from clinical (experientially-based) or statistical (from assembled data describing the characteristics of previous similar offenders) methods.[46] A similar approach, using eyewitness accounts to personal behavior, could produce a profile of an adversary leader and allow for the forecasting of potential responses to stimuli. Snook's statistical analysis indicates that "…most of the typologies used to create criminal profiles (CP) are in fact false typologies, the majority of CP approaches are based on an outdated theory of personality that lacks empirical support, and there is no compelling evidence that predictions made by professional profilers are significantly more accurate than those made by nonprofilers."[47]

Is an accurate model of adversary leader behavior a pipe dream, then? Pierce and Coon certainly seem to think so. They note, "Predicting a specific behavioral effect on a leader…might not be possible. The adversary leader might have little or no idea as to what factors actually drive his decisions…"[48] To buttress this assertion, they offer as partial proof the work of Carl Barksdale, a 2002 Naval War College graduate who analyzed the Soviet war in Afghanistan (1979-1989), the Vietnam War, and the Israeli departure from Lebanon (2000). Barksdale reviews the salient inputs received by various leaders (U.S., Israeli, and Soviet) and concludes that, "What exactly happened in the mind of the leader is not clear. We now know many of the inputs that were brought to bear on the decision; however, this does not reveal their salience in the mind of the leader. *It is doubtful any future system will ever be able to predict such interaction.*"[49] Note how the absence of evidence (of a connection between "salient inputs" and leader decisions) is once again construed as evidence of absence. Barksdale goes further, however, arguing that detailed knowledge of a nation's history, culture, and traditions is still insufficient to provide a forecasting tool that will permit one to know the mind of the adversary leader.

Despite this understandable pessimism, producing accurate (or semi-accurate) predictions of human behavior is as old as humanity itself. These have been, by necessity, ad hoc in nature—in effect, using a human brain (one's own) to infer the actions of the adversary's brain. Since the adversary may have fundamentally different logical constructs, cultural artifacts, and belief systems, the danger of mirror-imaging (i.e., assuming an enemy will react to stimuli in a fashion similar to one's own) is real and significant—many times leading to false conclusions.[50] Does this mean that all

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such attempts are doomed to fail? Or that perhaps we have attempted to base our hypotheses on incomplete and high-level behavioral data, when we should focus our efforts on more basic problems first?

Decision-making, and all human behavior, arises first in the wetware of the human brain. In the past century, we have obtained fundamental insights into the physiological workings of the brain, as well as the mental correlates of those physical states. While we have been as yet unable to construct an artificial brain, our understanding of neurons and neocortical columns, the interaction of various regions of the cerebral cortex, and their coupling with sense organs implies that an approximation or model of the human brain is not simply achievable in theory—it may soon be achievable in fact. In 2005, IBM and the Brain and Mind Institute of Lausanne, Switzerland, teamed to produce a full simulation of the human brain (down to the molecular level).[51] The project is expected to last a decade, has already demonstrated "mouse-level" and "rat-level" simulations[52] in near-real time, and it is not the only such effort underway. Elements of the US Defense Department are pursuing research in this arena as well.[53] This "low-level" analytic approach seeks to develop theories for the operation of brains. Once the low level theories are confirmed, higher-level hypotheses regarding the operation of the brain in circumstances of exposure to specific stimuli will no doubt be developed and tested.

Critics might argue, among other things, simulating a brain is not the same thing as simulating a mind, and this is no doubt true. But the prerequisite for building a mind—at least, a *human* mind—is constructing a model of the underlying substrate, the brain. Once this is achieved, in near real-time, real-time, or (eventually) at many orders

of magnitude more rapidly than events proceed naturally, the brain emulation can be fed inputs to allow the diagnosis of brain-related disease, forecasting of simple behaviors and responses, and perhaps the prediction of outcomes for higher-level logical processes. Might we discover that brain states are chaotic (inherently unpredictable, by virtue of their sensitivity to infinitesimally small differences in initial conditions)? Certainly. But even if this were the case, it would be possible to "rerun" such simulations as many times as necessary to extract probabilistic assessments of how the brain would react to the presented choice or set of choices. A "Monte Carlo" style simulation[54] of this type could provide exceedingly useful information, even if there is no absolute answer—simply knowing that a particular response was achieved in 30% (e.g., 3,000 of 10,000 simulated "trials") might represent useful data for the experimenter.[55]

To be clear: We know that simulating a brain should be *possible*—since brains exist.[56] Whether such a simulation will provide more accurate guidance concerning human behavior than "black box" psychological models (e.g., behaviorism, psychoanalysis, cognitivism) is a testable hypothesis that we will attempt to prove or disprove.[57] If we begin at the lowest level—in this case, the physiology of the brain—we will slowly but eventually be able to work our way up to higher-order processes that are of specific interest to the war practitioner. If we attempt to skip past these crucial low-order processes,[58] we will do so in vain, undoubtedly running afoul of poorly-validated heuristics and embedded theories that are simply wrong. Without the crucial low-level description, we will not be able to determine which of the higher-level theories are consistent with the brain's operation.

We must build on what we know, slowly and steadily, and recognize that what little we truly understand about brain processes (and the emergent human behavior we witness on a daily basis) remains in its infancy. This is the road to non-heuristical adversary behavior prediction—it is a long road, but what the journey lacks in speed, it will make up in reliability.

As a hedge, and for practical reasons, we can continue to guess at adversary intentions and actions through the use of low-reliability heuristics in the meantime. We may postulate that an enemy has cause to conceal his stratagems ("all warfare is based on deception") or that he will be forced to adopt asymmetric capabilities ("neutralize an enemy's technological or numerical superiority by fighting in ways that nullify it").[59] We should, however, refrain from calling a collection of such untested assertions a *theory* of adversary behavior.

Case Two: Establishing the Relevance of a Center or Centers of Gravity (COG). Another maxim drawn from *On War* concerns the existence (or otherwise) of a unitary (or otherwise) strategic center of gravity representing a focal point for the enemy's "strength, power, and resistance."[60] The precise meaning of Clausewitz's words have provoked considerable debate amongst war practitioners—especially in the wake of three major conflicts in Southwest Asia over the past two decades, each with a decidedly different outcome. Why so much gnashing of teeth over a seemingly simple construct?

Clausewitz formulated his hypothesis as follows, "…One must keep the dominant characteristics of both belligerents in mind. Out of these characteristics, a certain *center of gravity* develops, the hub of all power and movement, on which everything

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depends. That is the point against which all of our energies should be directed."[61] If

one can systematically identify such a hub—and then exert military effort or other

elements of national power against it, Clausewitz appears to promise a short route to

victory. To test its veracity, we might consider analyzing historical scenarios with an

eye to (1) recognizing a center of gravity, and (2) determining if action against that

center of gravity resulted in victory for the opposition. Skeptics might argue that (1) is at

best a subjective enterprise, while (2) may be so contaminated with other efforts

(against other elements of enemy power other than the center of gravity) that it is not

possible to separate the effects of each effort to determine whether specific action

against the COG made the difference.

Despite these potential obstacles, the concept of center of gravity has assumed

center stage in modern warfare. The US airpower theorist John A. Warden drew

inspiration (at least indirectly) from Clausewitz when he codified his concept of the Five

Rings, a construct used to model adversary systems, including fielded forces (the

exterior ring or COG), population, infrastructure, "system essentials," and adversary

leadership (the innermost ring/COG).[62] Warden's hypothesis was that the precision and

lethality of modern airpower permitted the delivery of effects against not only fielded

forces (the traditional foe, and typically the only one accessible to a nation's military) but

the inner rings as well.[63] Warden's hypothesis appeared to be borne out following the

first Persian Gulf War in 1991. A month-long air war, targeting critical vulnerabilities in

all of Warden's rings, brought down essential command and control links, air defense

networks, and elements of the key infrastructure supporting Saddam Hussein's Iraq,

immobilizing much of his fighting forces, limiting his and his commanders' situational

awareness, and preventing any significant defense against the short land war that followed. Does the US victory in 1991 thus represent a clear confirmation of the base hypothesis?

Perhaps not. The muddled outcome of the two wars fought by the US and its allies in the wake of the September 11th bombings throws Warden's theory into question: In both Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF), the identification and targeting of critical vulnerabilities within the adversary center (or centers) of gravity led to short-term successes. Mullah Omar's Taliban regime fell to the Northern Alliance on 13 November 2001, just over one month after US special operations forces entered the country, bent on eliminating Al Qaeda and forcing their hosts from power.[64,65] During OIF, the Hussein regime lost control of Baghdad after just three weeks, with Coalition forces declaring the military invasion over on Day 27, 15 April 2003.[66] In both of these instances, however, regime elements and their associates dispersed and covertly reassembled, conducting scattered but increasingly effective insurgencies. In both cases, the adversary adopted asymmetric tactics (e.g., improvised explosive devices, suicide bombings, bombings of sacred religious sites) to spur unrest and public discontent. Wars initially intended to be over within months became occupations which continue to the present day, with significant human resources—civilian and military, contractors, and coalition government members-- deployed in both theaters and likely to remain for some time. Did we fail to identify the appropriate center(s) of gravity? Or did the center of gravity change over time, as these wars became insurgencies—did we forget that the enemy gets a vote? Or is the

problem deeper? Is it possible that the concept of "center of gravity" is too simplistic to be useful in addressing a sociological phenomenon as complex as human warfare?

Let us return to the starting point, Clausewitz's base hypothesis. The formal definition of "center of gravity" is drawn from physics, and can be stated concisely as "that point within something at which gravity can be considered to act." It is possible to demonstrate mathematically that the vector sum of gravitational forces acting on a distributed body is equivalent to the force applied to a point particle containing the distributed body's mass, at the center of gravity. This simplification allows us to treat large, non-point masses (such as planets, stars, and other celestial bodies) as if they were point masses.

Clausewitz's attempt to draw an analogy from celestial mechanics to warfare is picturesque, provides a patina of scientific respectability, but essentially falls flat. The implication is that—in a battle, a campaign, or a long-term conflict with an adversary— there is a critical point, event, or other element which, if addressed, would yield victory as efficiently as the sum of a large number of actions applied across the battle space (to individual formations, at different times, in different locations). Why would this be true? In what way—in what *real* way—is a conflict between human entities (cities, states, armies) analogous to the interplay of particles in a gravitational field?

The likely answer is—in *no* (known) way. If we hold rigidly to the standard definition of center of gravity, then we can admit the existence of only a single COG— and (surprise!) there exists both doctrine and war practitioners who hold that this is indeed true.[67] Joe Strange takes such individuals—such as the wayward authors of Naval Doctrine Publication 1—to task by noting, "The assertion that there can be only

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one center of gravity is ludicrous. True, the enemy must have a resupply line. But is [a resupply line] the only thing he must have to sustain the fight?"[68]   The argument over the unitary nature of a Clausewitzian COG is a red herring—it results from the misapplication of the physical definition, further straining the analogy (in this case, to the breaking point). Just because we admit only one center of gravity in physics does not necessarily imply that any similar construct exists in complex human fields of endeavor, to include warfare.

In the end, we are led to a conclusion similar to that reached in the first case study. Human-based systems, group dynamics, and individual human behavior are complex phenomena that result from the interaction of minds with the environment. The mind itself is a high-order manifestation of physical processes occurring in human brains. We can attempt to short-circuit a deep understanding of these processes in favor of a "black box" approach which uses empirical assertions to describe high-level human behavior. If we choose this path, however, we will run headlong into the same sorts of difficulties that confound users of sociological and psychological models who attempt to predict serial killer or adversary leader behavior—such theories simply do not rest on a firm (analytical) foundation and likely contains significant sources of error. While astute observers such as Clausewitz may note patterns in human conflict that superficially resemble the actions of physical particles, what emerges are guidelines or rules of thumb, *not verifiable theory*.

A testable hypothesis intended to establish the existence of a concept similar to a physical center of gravity in human conflict would require two key elements as prerequisites: (1) a vastly greater understanding of the human brain, its lower- and

higher-order processes, and its interactions with the environment (to include other minds); and (2) a comprehensive analysis of the enemy system's non-human elements, including (but not limited to) transportation, energy, food supply, sanitation, and communications infrastructures, which permits the development of a suite of critical nodes and interconnections. Since (2) is an inherently simpler task than (1), insofar as it relies on the characterization of engineered systems, it can be performed today— witness the US Army's PMESII[69] (Political, Military, Economic, Social, Infrastructure, and Information) methodology adopted for operational planning and enemy system evaluation. Since this analysis *can* be performed, it is unsurprising that it is invested with greater predictive power than it could logically provide—one emphasizes the outcome of tools that are available, and often discounts those that are not. And yet it appears likely that this critical intersection between enemy system human and non-human elements is in fact *the* major source of unpredictability in our planning. The iterative nature of human transactions ("the enemy gets a vote," and the paradoxical nature of war[70]) tends to imply that critical vulnerabilities and "centers of gravity" do change over time, but that they might do so in predictable ways—assuming we expend the effort to model those parts of the enemy system (the human parts) where our knowledge and tools are currently weakest.

With an integrated model of the enemy in hand, a simulated adversary could be tested for weaknesses by applying force (military, diplomatic, economic, etc.) and observing the outcome of the simulation—repeatedly, with Monte Carlo methods described previously, to gain statistical significance. "Centers of gravity" (or their human behavioral analogs) may be identified. In some cases, one or more critical

vulnerabilities in these COGs may be available to be exploited. In others, there may be no such vulnerabilities, or an initial victory might transmogrify into a second conflict of different character (insurgency following a conventional war). In any event, the war practitioner will benefit from the emergence of a true hybrid human/non-human (engineered systems and environmental) model to take the place of the partial, heuristically-based model we rely upon today.

Conclusion

To conclude, we have attempted to describe a three-step process for applying scientific principles to the study of war theory. The steps—collection of relevant data, development of falsifiable hypotheses, and rigorous testing to disconfirm the hypotheses—is a standard paradigm for understanding physical as well as sociological phenomena.

The author examined two specific and problematic cases in war theory—adversary leader behavior prediction and the nature and proper identification of strategic "center(s) of gravity" within adversary nations or civilizations. Both of these cases exhibited the difficulty of establishing reliable methodologies for prediction when low-level (physical) processes are incompletely understood and the principal means for forecasting relies on "black box" models of higher-level (empirically observed) behavior. In both cases, what is clearly needed is concentration on lowest-common denominator science—predicting basic neurological processes, then extrapolating from those processes to higher-order logical schemes present in the brain. This will provide a secure foundation for the eventual prediction of individual and group behaviors, in concert with the natural environment and the engineered systems humans have placed

in the environment. War—like most human phenomena—is an emergent property of the human brain.

War is a human endeavor, and—as noted above—human endeavors are highly complex and not susceptible to easy prediction. Until recently, the very idea that we could understand the basic physical processes of the human brain and mind would have been rejected out of hand. Understandably, then, war theorists have tended to sidestep the question of whether or not their assertions are in fact demonstrably true or false in the aggregate, and look instead to compelling historical cases of questionable generalizability. While this is adequate to provide a commander or strategist with a "framework" for understanding war or his adversary, or heuristics that can assist the prosecution of a war, single events are not statistically significant. They may be compelling or well-told, but they may also be unusual or pathological cases. How can we ascertain the difference?

Apply science. Rigorously, without remorse, and without concern for the arduous journey ahead. It will not be easy: We have spent thirty centuries and more at war with one another, and have utterly failed to compile comprehensive databases that might have informed useful hypotheses. J.D. Singer, the IBM BlueGene developers pursuing artificial brains, and many others are on the right track, but it may well require many more years before there is sufficient data to formulate non-trivial propositions and rigorously test them. In the meantime, we will have to make do with the intuition and insight of war theorists to inform our strategic choices. Clausewitz famously describes the fog of war, but the rules of thumb and historical "just so" stories we have received from our ancestors dispense another, perhaps more insidious fog that surrounds our

ability to strategize or even think about war. Perhaps in another century or two, our

descendants will be able to celebrate the efforts of a sociologist Kepler, a Newton, or an

Einstein—theorists armed with real data and proposing testable theory—who made the

stunning breakthroughs which allowed the causes and conduct of war to be properly

understood, predicted, and finally harnessed in the service of mankind.

Endnotes

[1] Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007), 199.

[2] Carl Sagan, *Cosmos* (New York: Random House, 1980), 48-71. Sagan artfully describes the emergence of astronomy out of pseudoscientific astrology (itself an outgrowth of a far more empirical—if not precisely scientific—primitive astronomy practiced by prehistoric human societies).

[3] Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* (London: Routledge Classics, 2002), 266-267.

[4] Nassim Nicholas Taleb, "Opacity: What We Do Not See," http://www.fooledby randomness.com/notebook.htm (accessed March 14, 2009). Taleb notes (in section 79), "…empiricism is looking at data and formulating opinions congruent with the data (using a mental disease commonly called *statistical methods*). Wrong. The true meaning of empiricism is the avoidance of inductive generalizations outside the instances in which a given observation was made: you cannot extend the properties too aggressively outside the sample set of observation, particularly when you encounter slight dissimilarities. So an empirical doctor would focus on the *extremely similar*. History can only repeat itself in the exact circumstances of prior occurrences."

[5] If we fail to offer a suitable definition, we will spend a significant amount of time arguing semantical subtleties—shining examples of which include the oceans of ink spilled over the meaning of such terms as "Transformation," "Revolution in Military Affairs," "Irregular Warfare," and "Terrorism."

[6] Sun Tzu, *The Art of War*, Samuel Griffith, ed. (London: Oxford University Press, 1963), 63. The author notes that war is vital, must be studied assiduously, and is composed of five "fundamental factors" and "seven elements." He does not take the time to specifically define what it is (or what it is not).

[7] George Orwell, *1984* (New York: New American Library, 1949, 1961) 185-199. In the guise of Emmanuel Goldstein, the (likely mythical) intellectual opponent of Big Brother, Orwell describes war as a means for destroying the products of human civilization, which might otherwise be used to enrich society and cause the proletariat to rebel against its rulers. The Party's slogan, "War is Peace," reflects this paradox—that by consuming the works of human

labor in warfare, the ruling Party maintains its hold on power, and ensures "peace." Orwell's description of this war's purpose—while not a definition—is not out of line with Orend's comments regarding governance (q.v.).

[8] Carl von Clausewitz., *On War*, ed. Michael Howard and Peter Paret (Princeton, New Jersey: Princeton University Press, 1984), 75.

[9] Brian Orend, "War," The Stanford Encyclopedia of Philosophy (Fall 2008 edition), http://plato.stanford.edu/cgi-bin/encyclopedia/archinfo.cgi, 2008 (accessed September 12, 2008).

[10] Clausewitz, *On War*, 70-71.

[11] Karl Popper, *The Logic of Scientific Discovery* (New York: Routledge, 1992), 40. Popper would tell you that you are not actually in possession of a scientific *theory* unless it consists of a suite of testable (i.e., falsifiable, refutable) propositions.

[12] Clausewitz, *On War*, 374.

[13] There is nothing quite so difficult, yet so critically essential to progress in science, as the construction of repeatable tests that permit you to invalidate the theory you have so lovingly constructed. After all, multiple confirmations of your theory don't necessarily tell you whether your theory is conclusively right or wrong. A single disconfirmation, however, will provide you with everything you needed to know.

[14] Bernard Brodie, *War and Politics* (New York: MacMillan Publishing Co., 1973), 380. Brodie asserts that the Cold War "balance of terror" between the Soviet Union and the United States was "decidedly not delicate," in opposition to contemporaries such as Albert Wolhstetter, author of a well-read 1959 Foreign Affairs article on this topic. How does Brodie reach his conclusion? While he does not go so far as to suggest that our continued existence is proof enough, he admits, "…in view of the enormous disparities in nuclear capabilities between powers that have been at times enormously hostile to each other…that fact [that the world has not yet blown up] is itself impressive." This is classic *absence of evidence* construed as *evidence of absence*. Since we cannot (yet) rerun the timeline several thousand times in simulation and count the number of Armageddons that result, it is difficult to know what value to place on Brodie's theory. Perhaps we have just been very, very lucky.

[15] John Shy, "Jomini," in *Makers of Modern Strategy from Machiavelli to the Nuclear Age*, ed. Peter Paret (Princeton, New Jersey: Princeton University Press, 1986), 154-175. Jomini is characterized by Shy as "reductionist" and "prescriptive," taking a naïve view of science and attempting to apply it to the complex realm of human behavior in war. What is fascinating about this characterization is how non-scientific the Jominian methodology truly is. Shy notes, regarding Jomini's concept of interior lines, "…he failed to test, as a good scientist should, the 'null hypothesis'—the historical cases in which actual military experience did not conform to prediction based on his principles. Indeed, he discussed such cases…but was too little interested in the ways that they might have broadened or enriched his theory. These cases were, in short, treated as a threat to his position, and he discussed them only to preempt doubts and criticism." This is most emphatically *not* science. Disconfirmation of your hypothesis is the goal of proper testing—it allows the scientist to rethink the phenomena under investigation and formulate a more refined theory, which may be disconfirmed in its turn. This is how science progresses.

[16] Edward Luttwak, *Strategy: The Logic of War and Peace* (Cambridge, Massachusetts: Belknap Press of Harvard University Press, 1987), 142. How would the three-to-one "hypothesis" apply to an attack by nuclear-armed bombers against hardened, buried targets? How would one assign a measure of worth to attack and defense under these conditions, in order to test the theory? Is it even worth posing these questions?

[17] Colin Gray, *Modern Strategy* (London: Oxford University Press, 1999), 80.

[18] Complexity theory states that, when small variation in a system's initial state produce large variations in its future states, that system can be described as deterministically *chaotic*.

[19] Pareto, Vilfredo, *Cours d'économie politique professé à l'université de Lausanne*, ed. F. Rouge (Lausanne: Librairie de l'Université, 1897). Pareto's power law described the evidently non-Gaussian distribution of income in various societies. Instead of being randomly distributed, income and wealth was shown by Pareto to be substantially concentrated, with a very few individuals amassing the vast majority of wealth. His formula holds for subsets of the population as well.

[20] Isaac Asimov, *Foundation* (New York: Gnome Press, 1951). Asimov described (in admittedly vague terms) a theory of *psychohistory*, which—when applied across extremely large numbers of human beings, much larger than exist on earth today—allows the practitioner of the discipline to predict future events with uncanny accuracy.

[21] Gray, *Modern Strategy,* 24, 26-44. The author delineates 17 "dimensions" which influence polity strategy (and thus war), to include: people, society, culture, politics, ethics, economics and logistics, organization, military administration, information and intelligence, strategic theory and doctrine, technology, military operations, command, geography, friction, chance, and uncertainty, the adversary (who presumably can be analyzed in the context of the sixteen other dimensions), and time. Unfortunately, the factors are composed of subfactors too numerous to be described, much less analyzed, and Gray is content only to say, "…the precise number does not matter so long as everything of importance is…corralled."

[22] J. David Singer, *Explaining War: Selected Papers from the Correlates of War Project* (Beverly Hills, California: Sage Publications, 1979), 21.

[23] Ibid., 7.

[24] Trevor Dupuy, *Numbers, Predictions, and War: Using History to Evaluate Combat Factors and Predict the Outcome of Battles*, (Indianapolis, Indiana: Bobbs-Merrill Company, Inc., 1979), 37-39. Dupuy undertakes an exhaustive effort to quantify the outcomes of war, with a strong focus on weapons' effects. What are understandably missing are the human behavioral factors that are poorly understood and difficult to model. Depuy himself is forced to admit, "…subjective qualities [such as leadership, training, and morale] are almost impossible to assess in absolute terms with complete objectivity." He is led to "assessment indirectly through measurement of their effects." This is the epitome of the empirical methodology—curve-fitting and "fudge factor" creation through iterative observation and modeling. The problem is that Dupuy is observing high-level behavior (e.g., large military forces composed of thousands of individuals in conflict) and attempting to construct a high-level model for their actions without any tie-in to the underlying behavioral phenomena that drive war—the low-level neurophysiology of human brains.

[25] Ibid., 32-33.

[26] Sun Tzu, *The Art of War*, 77-78.

[27] Nassim Nicholas Taleb, "Black Swan Glossary," http://www.fooledby randomness. com/blackswanglossary.htm (accessed March 14, 2009).

[28] Clausewitz, *On War*, 170-172. While Clausewitz uses historical examples to good effect, he is deeply familiar with the way they may be misused. He notes, "If…some historical event is being presented in order to demonstrate a general truth, care must be taken that every aspect bearing on the truth…is fully and circumstantially developed…to the extent that this cannot be done, the proof is weakened, and the more necessary it will be to use a number of cases to supply the evidence missing in that one." He then goes on to describe why a proposition such as, "cavalry should be placed in the rear of the infantry rather than in line with it," will require a detailed accounting and not simply a citation of battles in which cavalry used properly were deemed successes, and those in which they were used improperly, failures.

[29] Ibid., 173.

[30] The reader might object that waiting decades or centuries is utterly impractical and that this invalidates the author's thesis, or at the very least discounts it substantially. But that would amount to an extreme oversimplification—anecdotal evidence, scattered observations, and rules of thumb have demonstrable value. But they are not scientific, and they do not amount to a true theory of war. We may have to wait a long time before a sketchy theory of war emerges, and it will likely only follow on the heels of a lower-level theory of human behavior.

[31] Clausewitz, *On War*, 173.

[32] Errol Henderson and J. David Singer, "Civil War in the Post-Colonial World, 1946-92," *Journal of Peace Research* 37, No. 3 (May 2000), 275-299, in JSTOR (accessed September 16, 2008). This research covers 53 civil war in 90 states. The authors *speculate* that semi-democracy (the factor most highly correlated with incidences of civil war) creates fertile ground for insurgencies as a result of its inherent structural weaknesses. Once a semi-democracy attempts repression to halt a nascent insurgency, it tends to accelerate the insurgency—due to its inability to prosecute the repressive policies.

[33] Sagan, *Cosmos*, 56-71.

[34] Sun Tzu, *The Art of War*, 66, 73, 77.

[35] Whether or not the peoples of the countries in question "benefited" from the imposition of Maoist or Vietminh totalitarianism is another question.

[36] Fred Kaplan, "The Flaw in Shock and Awe: Rumsfeld's Theory of Warfare Isn't Working, At Least So Far," March 26, 2003, http://www.slate.com/id/2080745 (accessed September 17, 2008).

[37] Andrew Bacevich, "Why Read Clausewitz When Shock and Awe Can Make a Clean Sweep of Things? A Review of Cobra II: The Inside Story of the Invasion and Occupation of Iraq by Bernard Trainor and Michael Gordon" London Review of Books Online, June 8, 2006, http://www.lrb.co.uk/v28/n11/bace01_.html (accessed September 17, 2008).

[38] Taleb, *The Black Swan: The Impact of the Highly Improbable*, 199.

[39] Clausewitz, *On War*, 366, 117, 119.

[40] Were we to bring him into the present, it might be possible to sway Clausewitz into modifying his stance on intelligence. Perhaps "most HUMINT is false" would better represent the current state of play.

[41] Ethical and practical considerations will obviously limit the scope of any "real world" testing.

[42] Sun Tzu, *The Art of War*, 129.

[43] William G. Pierce, Robert C. Coon, "Understanding the Link Between Center of Gravity and Mission Accomplishment," *Military Review* (May-June 2007): 76-84.

[44] This could be as simple as developing a dossier based on the leader's public and private statements, attitudes, and behavior. Of course, the reliability of such an approach is much in doubt—if even measurable.

[45] Rex Hudson, *The Sociology and Psychology of Terrorism: Who Becomes a Terrorist and Why?* (Washington, D.C.: Library of Congress Federal Research Division, 1999), http://www.loc.gov/rr/frd/pdf-files/Soc_Psych_of_Terrorism.pdf (accessed March 3, 2009).

[46] Brent Snook, Richard M. Cullen, et. al., "The Criminal Profiling Illusion: What's Behind All the Smoke and Mirrors," *Criminal Justice and Behavior* 35, No. 10 (October 2008), 1257-1276.

[47] Ibid., 1259.

[48] Pierce and Coon, "Understanding the Link," 80.

[49] Carl A. Barksdale, *The Network Centric Operations—Effects-Based Operations Marriage: Can it Enable Prediction of "Higher Order" Effects on the Will of the Adversary?,* Research Paper (Newport, Rhode Island: Naval War College, May 13, 2002), 17. This appears to be a prime example of an argument from personal incredulity.

[50] For example, this author believes it is not going out on much of a limb to say that the US (flying) public believed that airline hijackers would not destroy the planes they hijack—a misreading of jihadist martyrdom psychology that was made abundantly clear to us on 11 September 2001.

[51] Duncan Graham-Rowe, "Mission to Build a Simulated Brain Begins," *New Scientist*, June 6, 2005, http://www.newscientist.com/article/dn7470 (accessed February 1, 2009).

[52] Jamais Cascio, "The Early Signs of the Long Tomorrow," *Open The Future* website, http://openthefuture.com/2007/04/the_early_signs_of_the_long_to.html, 24 April 2007 (accessed 1 February 2009).

[53] Daniel Terdiman, "IBM Gets DARPA Cognitive Computing Contract," CNET, November 19, 2008, http://news.cnet.com/8301-13772_3-10103355-52.html (accessed February 1, 2009).

[54] "Introduction to Monte Carlo Methods," Computational Science Education Project, 1995, http://www.ipp.mpg.de/de/for/bereiche/stellarator/Comp_sci/CompScience/ csep/csep1.phy.ornl.gov/mc/node1.html#SECTION00010000000000000000 (accessed February 26, 2009). Monte Carlo methods rely on multiple "samplings" or "trials" based on randomly selected inputs.

[55] Recognizing, as we must, that all models are approximations, and that we should take care not to invest them with greater explanatory power than they can realistically have.

[56] If by no other method then growing them naturally!

[57] In theory, this could be done by performing a series of single- and multiple-brain simulations of increasing complexity, comparing the results of each experiment to actual responses recorded in one or more human subjects. See footnote 55.

[58] Of course, there are exceptions. The higher-order description of continuum thermodynamics produces results which are (thankfully) identical with the lower-order description of statistical mechanics (probability theory applied to large groups of individual particles)—and thermodynamics was formulated *before* statistical mechanics. See Peter Landsberg, *Thermodynamics and Statistical Mechanics* (New York: Dover Publications, 1991).

[59] Vincent Goulding, Jr., "Back to the Future with Asymmetric Warfare," *Parameters* 30, No. 4 (Winter 2000-01): 21-30.

[60] Joe Strange, *Centers of Gravity and Critical Vulnerabilities: Building on the Clausewitzian Foundation So That We Can All Speak the Same Language* (Quantico, Virginia: Marine Corps University, 1996).

[61] Clausewitz, *On War*, 595-596.

[62] John A. Warden, "Air Theory for the Twenty-First Century," in *Battlefield of the Future: Twenty-First Century Warfare Issues*, September 1995, http://www.airpower.maxwell. af.mil/ airchronicles/battle/chp4.html, (accessed February 1, 2009).

[63] Note that these rings are defined as "sources of strength," although they may contain critical vulnerabilities that permit them to be overcome.

[64] "Kabul Falls to Northern Alliance," BBC News Online, November 13, 2001, http://news.bbc.co.uk/2/hi /south_asia/1653137.stm (accessed February 1, 2009).

[65] Patrick Cockburn, "Why? Six Years on from the Invasion of Afghanistan," *The Independent*, October 6, 2007, http://www.independent.co.uk/news/world/asia/why-six-years-on-from-the-invasion-of-afghanistan-396093.html (accessed February 1, 2009).

[66] "Timeline, 1990-2008," ProCon.org, January 22, 2009, http://usiraq.procon.org/ viewresource.asp? resourceID=670#war2003 (accessed 1 February 1, 2009).

[67] For example, the master himself: "Our position, then, is that a theater of war, be it large or small, and the forces stationed there, no matter what their size, represent the sort of unity in which a single center of gravity can be identified. That is the place where the decision should be reached…" Clausewitz, *On War*, 487.

[68] Strange, *Centers of Gravity*, 123.

[69] Greg Zacharias, *Behavioral Modeling and Simulation* (Washington, D.C.: National Academies Press, 2008), 55-58.

[70] Edward Luttwak, *Strategy: The Logic of War and Peace* (Cambridge, Massachusetts: Belknap Press of Harvard University Press, 1987), 13-15.